International Journal of Mechanical and Production
Engineering Research and Development (IJMPERD)
ISSN(P): 2249-6890; ISSN(E): 2249-8001
Vol. 6, Issue 2, Apr 2016, 37-44

TRANS STELLAR
• Journal Publications • Research Consultancy

MULTITASKING

VYANKATESH S. KULKARNI[1] & BRAJESH TRIPATHI[2]

[1]*Research Scholar, Department of Mechanical Engineering, JSPM-BIT, Barshi, Solapur, Maharashtra, India*

[2]*Department of Mechanical Engineering, University College of Engineering, Kota, Rajasthan, India*

ABSTRACT

Multitasking (often referred to as timesharing) has been extensively studied from a mental workload and humanperformance perspective. However, a relatively small amount of research has been conducted in the manufacturingdomain (Wickens, 1992). As the level of system automation increases, the role of the human has shifted from thatof a manual controller to system supervisor (Sheridan and Johannsen, 1976). According to Sheridan (1994),"human operators in AMS make their way among machines, inspecting parts, observingdisplays, and modifyingcontrol settings or keying in commands, most of it through computer-mediated control panels adjacent to variousmachines." This role of human operators in AMS has been identified as supervisory control in this paper

***KEYWORDS:** Human Supervisory Control, General paradigm of supervisory control (Sheridan, 1976), Capabilities of human and computer in planning/scheduling tasks of AMS (Nakamura, and Salvendy, 1994), Different type of disturbances in AMS (Kuivanen, 1996) , Determinants of Multitasking Performance, Performance-resource function for multitasking (Wickens, 1992)*

Received: Mar 01, 2016**; Accepted:** Mar 10, 2016**; Published:** Apr 07, 2016**; Paper Id.:** IJMPERDAPR20164

Original Article

INTRODUCTION

Multitasking (often referred to as timesharing) has been extensively studied from a mental workload and human performance perspective. However, a relatively small amount of research has been conducted in the manufacturing domain (Wickens, 1992). As the level of system automation increases, the role of the human has shifted from that of a manual controller to system supervisor (Sheridan and Johannsen, 1976). According to Sheridan (1994), "human operators in AMS make their way among machines, inspecting parts, observing displays, and modifying control settings or keying in commands, most of it through computer-mediated control panels adjacent to various machines." This role of human operators in AMS has been identified as supervisory control. [26]

Human Supervisory Control

Supervisory control refers to one or more human operators programming and receiving information from a computer that interconnects through artificial effectors and sensors to the controlled process or task environment (Sheridan, 1987). Ammons, Govindaraj, and Mitchell (1988) described the supervisory controller as "an operator responsible for a group of complex machinery where the operations require intermittent attention and depend on higher-levelperceptual and cognitive functions." Sheridan (1976) defined a general paradigm of supervisory control consisting of five functions: 1) Plan, 2) Teach, 3) Monitor, 4) Intervene, and 5) Learn. For each of the main supervisory functions the computer provides decision-aiding and implementation capabilities, as shown in Figure 1. A description of these functions is presented in Figure 2.

Job scheduling, inventory planning, and problem solving (disturbance control) have been among

the supervisory control responsibilities commonly assigned to human operators in AMS (Suri and Whitney, 1984; Ammons et al., 1988). The capabilities of humans and computers in AMS planning/scheduling tasks are presented in Table 1 (Nakamura and Salvendy, 1994). Table 2 shows examples of different types of unexpected contingencies (disturbances) in AMS (Kuivanen, 1996). Ammons et al. (1988) stated that two ways in which the unique skills of the human decision maker are used in supervisory control are to fine-tune or refine standard operating procedures for particular system states and to compensate for unplanned events and unexpected contingencies.

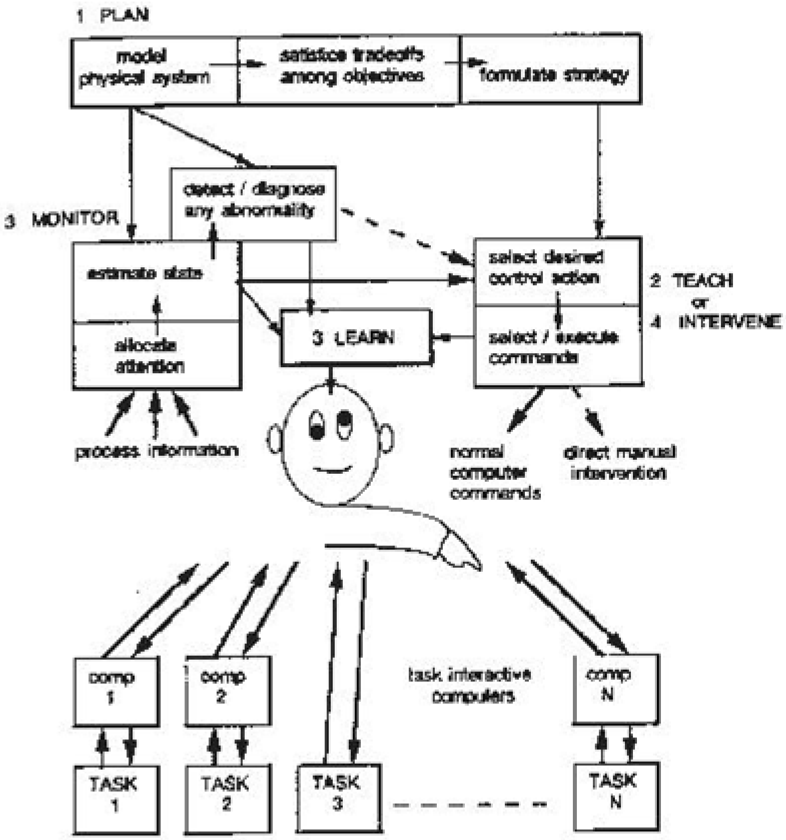

Figure 1: General Paradigm of Supervisory Control (Sheridan, 1976)

Plan

- Model the physical system to be controlled
- Decide on overall goal or goals, the objective function, tradeoffs among goals, and criteria for handling uncertainties
- Formulate a strategy or general procedure

Teach

- Select the control action to best achieve the desired goal
- Select and execute the commands to computers to achieve the goal

Monitor

- Allocate attention appropriately among the various subsystems to measure salient state variables
- Estimate the current state of the system
- Detect and diagnose any abnormality

Intervene

- Make minor adjustments of system parameters when necessary, as the automatic control continues take over
- Manual control if there has been a failure of the automatic control
- Abort the process in case of a major failure

Learn

- Develop understanding of and trust in the system
- Gain experience so as to do better next time

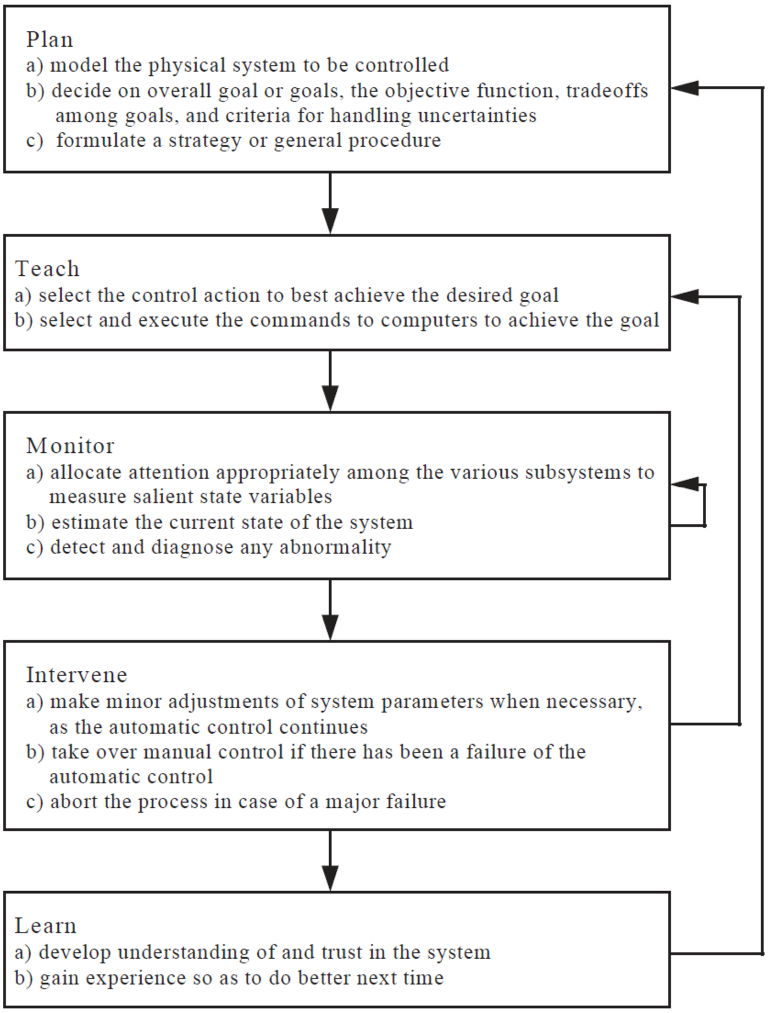

Figure 2: Temporal Nesting of the General Paradigm of Supervisory Control Functions (Sheridan, 1976)

Table 1: Capabilities of Human and Computer in Planning/Scheduling Tasks of AMS (Nakamura, and Salvendy, 1994)

Subtask	Description	Computer	Human
1. Detection	• Detect information and data for jobs and machines.	• Computer can easily detect information and data.	• Human takes a long time to detect the presence of information and data
2. Identification of system status	• Identify the present state of the system.	• If the identified pattern was predetermined, computer can quickly identify it.	• Human can recognize the important features in the planning / scheduling environment. (but this is nonlinguistic knowledge.)
3. Interpretation	• Interpret performance criteria and set the final goal for planning / scheduling.	• Computer can decide if the program connecting the present state with the final goal is stored.	• Human can set the reasonable goal from among many criteria which conflict with each other.
4. Order selection	• Select an order to be scheduled according to a priority.	• Heuristic algorithm can provide a "good" solution, but no guarantee on optimal one.	• Human intuition makes the best feasible solution
5. Time assignment	• Determine the start time and finish time for each operation of the selected order.	• It is difficult to take balance between job waiting time and machine idle time.	• Coordinating human with computer helps to determine efficient time assignment.
6. Resource allocation	• Select the resources (machines, tools, fixtures, NC program, etc.) to produce an order.	• Computer program can easily check whether machines tools, fixtures and NC program are available.	• Human selects many alternative solutions.
7. Evaluation and modification	• Evaluate the plan / schedule and if not satisfied, modify it.	• Poor, but updates the overall plan / schedule at least once every minute.	• Human modifies overall plan / schedule with flexible decision making abilities.
8. Generation	• Generate the plan / schedule sheet and issue it to the floor.	• Computer can do it very easily.	• Slow, not suitable.
9. Control	• Check the difference between the plan / schedule and the practice.	• Computer can do it easily under normal conditions.	• Human can adapt at abnormal conditions.

Table 2: Different Type of Disturbances in AMS (Kuivanen, 1996)

Target Group	Viewpoint	Definition	Example of the Cause of the Disturbance
General	All the situations concerning the organization, technique, or human action	A disturbance is an unplanned or undesirable state or function of the	—a missing work order —machine or device failure – broken tool —overloading —insufficient training
Operator of the system	All the situations that harm the normal normalworking routine	A disturbance is a a state or function of the system, which causes extra work	—error in the work program —error in the work —broken tool —machine or device failure
Maintenance	All the situa tions, that make it necessary for the maintenance personnel to take action towards the systems operation	A disturbance is a state or function of the system that requires remedial actions	—machine or device failure —overloading — maintenance and cleaning
Labor management and design	All the situations that prevent production	A disturbance is a state or function of the system which stops production	—raw materials, tools, or plans missing —machine or device -machine or device failure —workers or key personnel taken ill —strike
Production management	All that disables a delivery in agreed time	A disturbance is a state or function of the system, which makes it impossible for the producer to deliver the products to the customer in agreed time	-strike —overloading —machine and device failure —bad quality
Marketing	All the events in production, that complicate marketing	A distance is a state or function of the system, which disables or makes it makes it difficult to make a business agreement	—too long time of delivery —inferior quality

Determinants of Multitasking Performance

Different mental models have been used to describe multitasking performance. Scheduling, switching, confusion, cooperation, and processing resources are mechanisms often identified as determinants of multitasking performance (Damos, 1991; Adams, Tenney, and Pew, 1991; Wickens, 1992). In particular, the concept of processing resources is the basis for understanding the other mechanisms, and hence for multitasking performance. According to Wickens (1991), the resources concept is founded on the underlying assumption that the human operator has a limited capacity for processing resources that may be allocated to task performance; therefore, multitasking can lead to one or more tasks with less resources than required, causing a performance deterioration. This deterioration in the performance of one task because of competition with another task for critical resources is known as interference.

Two major processing resources theories of task performance areSingle-Resource Theory and Multiple-Resources Theory. The Single-Resource theory proposed by Kahneman (1973) postulates one undifferentiated limited pool of resources available to all tasks and mental activities. According to this theory, multitasking performance declines as the difficulty of one of the tasks increases, because it demands more resources from the limited pool, thus leaving fewer resources for performing the other tasks. Sanders and McCormick (1993) indicated that the Single-Resource Theory has difficulty explaining: 1) why tasks that require the same memory codes or processing modalities interfere more than tasks not sharing the same memory codes or processing modalities, 2) why with some combinations of tasks increasing the difficulty of one task has no effect on the performance of the others, and 3) why some tasks can betime-shared perfectly. According to Sanders and McCormick (1993), these three issues can be explained by the Multiple-Resources Theory proposed by Wickens (1984).

The Multiple-Resources Theory proposes that there are three dimensions along which resources can be allocated. The first dimension is stages (encoding and central processing vs. responding), which explains why tasks requiring response selection and allocation resources are not disrupted by tasks requiring central processing resources.[32]

The second dimension is input modality (auditory vs. visual), which explains why multitasking is better when the tasks do not require resources from the same modality than when they do. The third dimension is processing codes (spatial vs. verbal), which explains why multitasking is performed better when one task involves moving or positioning objects in space and the other involves language or logical operations. In addition to the three dimensions mentioned above, this theory suggests a response dimension (vocal vs. manual), which explains why multitasking is performed better when the tasks responses are of opposite types. Although the Multiple-Resources Theory was developed based on dual task multitasking, it can be used to explain more complex multitasking.

Scheduling and switching are highly influential on performance for both dual-taskand more complex multitasking. The operator's scheduling and switching ability depends on an understanding of the temporal constraints, the objective, and the cost associated with each task (Wood, 1982; Moray, Dessouky, Kijowski, and Adapathya,1990). Poor scheduling, inefficient switching between tasks, or insufficient time to do the multiple tasks sequentially will force the person to engage in concurrent processing. Wickens (1991) indicated that when the operator is engaged in concurrent processing, multitasking performance will be influenced by: 1) confusion (elements of one task become confused with the processing of another task because of their similarity), 2) cooperation between task processes (caused by high similarity of processing routines), and 3) competition for task resources. When the amount of resources demanded by the multiple tasks exceeds the amount of the operator's mental resources available, he or she will experience mental workload, consequently decreasing

multitasking performance (McCloy, Derrick, and Wickens, 1983; Bi and Salvendy, 1994). Figure 3 shows the relationship among theperformance-resource function for multitasking (Wickens, 1992). Sheridan (1994) stated that mental workload is very important for supervisory control in AMS where the human operator is constantly called upon to do multiple complex sensory and judgmental tasks. The central issue for vigilance research is to determine the effect of the additional tasks to the vigilance performance (Craig, 1991).

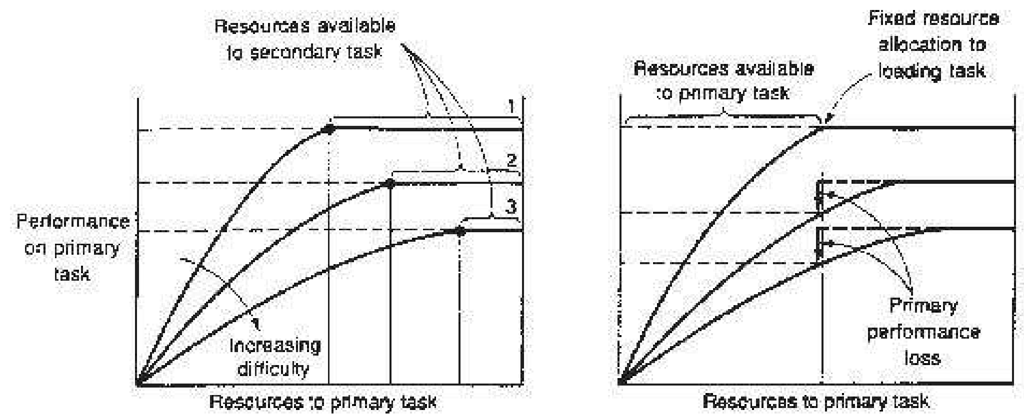

Figure 3: Performance-Resource Function for Multitasking (Wickens, 1992)

Research Objectives

There are still a surprising number of parts in AMS that can only be inspected by means of human visual sensory detection. Even when the quality inspection search component has been automated, human operators must make a final decision on the acceptability of a manufactured part. In many cases, this judgment must be made on the basis of a comparison with a memorized criteria for acceptable parts. The objective of this research was to characterize the operator's performance in the quality inspection task while conducting multitasking in an AMS.

CONCLUSIONS

The experiment tested the following hypotheses:

Hypothesis 1: The operator's decision making component of the quality inspection task in AMS will be significantly affected by the appearance of different types of defects in the units being produced.

Hypothesis 2: The operator's decision making component of the quality inspection task in AMS will be significantly affected by multitasking.

Hypothesis 3: The operator's decision making component of the quality inspection task in AMS will be significantly affected by the interaction of multitasking with the appearance of different types of defects in the units being produced.

ACKNOWLEDGEMENTS

To my Guide and Parents for their expertise, encouragement, invaluable assistance, guidance, advice and their patience with me throughout my study. All the learners who selflessly volunteered to be part of this study and most of all their parents for giving them permission to participateI wish to express my sincere gratitude

REFERENCES

1. *Juran and Gryna, 1980*
2. *Bennet, 1975; Konz, Peterson, and Joshi, 1981; Schilling, 1982*
3. *Drury, 1992b*
4. *Wang and Drury, 1989*
5. *Drury and Prabhu, 1994*
6. *Morawski, Drury, and Karwan, 1980*
7. *Howarth and Bloomfields, 1971*